CHAPTER 1

INTRODUCTION

1.1 Background of the Study

On 1st January 2017, non-sustainable clam shell containers made from polystyrene had been banned in the Federal Territories. There are only biodegradable products will be allowed to be used in Kuala Lumpur, Putrajaya and Labuan. This ruling was implemented not only in mention area but also to the other places and University Malaysia Pahang was not excluded. This practice was claimed as an effort to preserve the environment. The ban of polystyrene is laudable, however the act have given huge impact to the manufacturer and the industry of the plastic in Malaysia. Hence, graphene reinforced polystyrene nanocomposite had been research as an alternative to widen the application of the polystyrene.

Graphene is a thin layer of pure carbon that can be categorized as filler that usually obtained by mechanical exfoliation of graphite or synthesized by chemical vapor deposition (CVD). According to Hu et al. (2014) it has already been demonstrated that the introduction of even a small fraction of a graphene component can dramatically improve the mechanical performance of the variety of the polymeric matrices and some extraordinary reinforcing and functional properties have been reported very recently. These unique characteristics of graphene inspired us to study on the content of graphene reinforced polymer matrix to get optimum result based on their combination of mechanical properties which is tensile, flexural and impact properties. Besides that, the morphology and chemical interaction of the nanocomposites will be investigated.

Polymer matrix such as polystyrene is a type of polymer with thermoplastic properties, the product from the petroleum-derived monomer, styrene. Moreover,

Polystyrene is a versatile plastic used across all over the industries. As a hard, solid plastic, it is often used in products that require clarity, such as food packaging and laboratory ware. Besides that, it is usually offered at a lower price point than many other plastics. However, polystyrene's unsatisfactory mechanical property which is low impact strength causes it breaks very easily making it remain obstacles preventing this material from being used widely in other applications. The potential of graphene reinforced in polystyrene matrix of nanocomposites has gained attention in creating new material that offers composites that are stronger, stiffer and lighter.

The essential improvement of mechanical properties attributed to the good chemical bonding and dispersion of graphene nanosheets. According to (Wang, et al., 2015) the formation of chemical bonding between graphene and polystyrene serves to increase the efficiency of stress transfer across the nanofiller/polymer interface when the graphene/polystyrene composites we elongated. Recent experiments show that remarkable enhancement of the mechanical properties (Young's modulus, strength and toughness) could be established through introducing various functional groups, such as divalent ions and polymers (Liu, et al., 2012). However, increase of temperature will loss the functional group in thermal reduction in obtaining homogeneous dispersion in polymeric matrix melts especially in non-polar polymers (Wang et al., 2012).

1.2 Motivation

Graphene offer new opportunities to develop polymer material with superior properties. The main focus of this research is to create another application for polystyrene to reduce the application in disposable container which is the main contributors of producing waste. The environmental issues that related to the polystyrene become driving forces in order to create this material. This research is expected to be able to expand the use of polystyrene in wider applications. Other than that, the increasing publications on graphene based composite materials remarkably owing some exceptional properties of graphene. Although there are many works reported on the use of Graphene as nanofiller in polymer matrix, there is still plenty of scope for improvement specifically for Graphene-Polystyrene nanocomposites. Future development of melt melting for GPS nanocomposite manufacturing should be focused

on several aspects, i.e. to be able to maintain the quality of the material, low usage of fabrication material and longer material life.

1.3 Problem Statement

The overview of the issues in manufacturing graphene-polystyrene nanocomposite has been briefly explained in section 1.1. The superior properties of graphene are reflected in the graphene-incorporated polymer nanocomposites, showing greater mechanical, thermal, electrical, and other properties compared to neat polymer. Since graphene sheets are inherently stacked in graphite due to the high van der Waals forces between adjacent layers, the exfoliation and incorporation of graphene into polymer matrix to synthesize graphene reinforced polymer is quite difficult, (Anandan, *et al.*, 2014). In addition, graphene is a material with a low bulk density, and feeding large amounts of graphene into the polymer melt is difficult, especially in the case of high loading (Shen, *et al.*, 2011). However the problem can be overcome through melt blending technique. According to Shen (2011), indicating the melt blending is the main reason that led to enhanced interactions between graphene and PS components. The researcher highlight, high temperature and strong shear forces are usually involved during the melt blending process, which tends to fracture the nanoparticle aggregates and endow polymer chains with the ability to diffuse into the gaps of the nanoparticle interlayer. Although graphene-polystyrene recently being reported by several researchers, the studies are limited to certain properties such as electrical, electromagnetic shielding and corrosion. There is not much attention on the effect of graphene content towards mechanical properties of the graphene-polystyrene composite. Therefore, this study will investigate the content of graphene in the polystyrene and to ensure there is dispersion between the materials through melt blending technique.

1.4 Objectives

One of the most important aspects of materials development in thermoplastics engineering is to achieve a good combination of mechanical properties and processability at a moderate cost. The objective of this research is to investigate and